

WHAT IS CLAIMED IS:

1. A method for communicating information via a communication channel connecting a transmitting side and a receiving side, involving frequency modulation with a modulation index  $M$  that is not greater than 0.2 to thus compress a bandwidth of an information signal to have a small or very small frequency deviation at the transmitting side of the communication channel and in the communication channel, the method comprising:

frequency modulating an information signal with a modulation index  $M$  that is not greater than 0.2 to compress a bandwidth of the information signal to form a narrow band or very narrow band frequency-modulated information signal having a small or very small frequency deviation at the transmitting side of a narrow or very narrow band communication channel and in said communication channel;

suppressing upper and lower sidebands of the narrow band or very narrow band frequency-modulated information signal;

transmitting, via the communication channel, said narrow band or very narrow band frequency-modulated information signal with the suppressed upper and lower sidebands;

receiving the narrow band or very narrow band frequency-modulated information signal with the suppressed upper and lower sidebands from the communication channel at the receiving side of the communication channel; and

expanding the frequency deviation of the received narrow band or very narrow band frequency-modulated information signal with the suppressed upper and lower sidebands at the receiving side without expanding a bandwidth of said communication channel so as to form an expanded-frequency deviation information signal, the step of expanding for improving a signal-to-noise ratio and performed such that a bandwidth of said narrow band or very narrow band communication channel is never expanded.

2. The method as set forth in claim 1, further comprising:

converting the expanded-frequency-deviation information signal to a low frequency signal or audio signal.

3. The method as set forth in claim 1, further comprising:

further processing the expanded-frequency-deviation frequency modulated information signal.

4. The method as set forth in claim 1, further comprising:

converting the narrowband or very narrowband frequency-modulated information signal with suppressed upper and lower sidebands received from the communication channel to an intermediate frequency (IF) information signal before expanding its frequency deviation.

5. The method as set forth in claim 4, further comprising:

passing the IF information signal through a half wave rectifier and schmitt trigger; and

cleaning an information signal output by the schmitt trigger with a wave shaping circuit.

6. The method as set forth in claim 1, wherein the expanding step includes:

expanding the frequency deviation of the received narrowband or very narrowband frequency-modulated information signal with the suppressed upper and lower sidebands by frequency multiplication.

7. The method as set forth in claim 1, wherein the expanding step includes:

expanding the frequency deviation of the received narrowband or very narrowband frequency-modulated information signal with the suppressed upper and lower sidebands by a phase-lock loop (PLL) frequency multiplier.

8. The method as set forth in claim 1, further comprising:

removing noise from the narrowband or very narrowband frequency-modulated information signal with the suppressed upper and lower sidebands received from the communication channel before converting said narrowband or very narrowband

frequency-modulated information signal with the suppressed upper and lower sidebands to a low frequency signal or audio signal.

9. The method as set forth in claim 1, further comprising after the step of expanding the step of demodulating the expanded-frequency-deviation information signal to output an audio signal having sound quality comparable to sound recorded on CD-ROM.

10. A receiver for receiving and processing narrow band or very narrow band frequency-modulated information signals with suppressed upper and lower sidebands that have a predetermined small or very small frequency deviation due to compression of transmitted signals, and that have been transmitted over a narrow band or very narrow band communication channel, the receiver comprising:

means for receiving from the communication channel the narrow band or very narrow band frequency-modulated information signals with the suppressed upper and lower sidebands, said narrow band or very narrow band frequency-modulated information signals with the suppressed upper and lower sidebands having the predetermined small or very small frequency deviation; and

a circuit that expands the predetermined small or very small predetermined frequency deviation of the received narrow band or very narrow band frequency-modulated information signals with the suppressed upper and lower sidebands..

11. The receiver according to claim 10, wherein the frequency deviation expanding circuit includes:

a phase lock loop circuit including a frequency divider having a dividing ratio that corresponds to a selected expansion of the frequency deviation.

12. The receiver according to claim 11, wherein an output signal of the phase lock loop circuit is down-converted to an intermediate frequency information signal.

13. The receiver according to claim 10, wherein the frequency deviation expanding circuit includes:

a circuit having frequency-multiplying characteristics; and

a filter, connected to an output of the circuit having frequency-multiplying characteristics, the filter passing a multiplied-frequency signal component.

14. The receiver according to claim 10, further comprising:

means for removing noise from information signals from the receiving means before said signals from said receiving means are converted to a low frequency signal or audio signal.

15. A transmitter for transmitting an information signal via a communication channel connecting a transmitting side and a receiving side, involving frequency modulation with a modulation index  $M$  that is not greater than 0.2 to thus compress a bandwidth of the information signal to have a small or very small frequency deviation at the transmitting side of the communication channel and in the communication channel, the transmitter comprising:

means for frequency modulating an information signal with a modulation index  $M$  that is not greater than 0.2 to compress a bandwidth of the information signal to form a narrow band or very narrow band frequency-modulated information signal having a small or very small frequency deviation at the transmitting side of a narrow or very narrow band communication channel and in said communication channel; and

means for suppressing upper and lower sidebands of the narrow band or very narrow band frequency-modulated information signal prior to transmission.

16. The transmitter according to claim 15, wherein said means for suppressing includes a bandpass filter.

17. A method for communicating information via a communication channel connecting a transmitting side and a receiving side, involving phase modulation with a modulation index  $M$  that is not greater than 0.2 to thus compress a bandwidth of an

information signal to have a small or very small frequency deviation at the transmitting side of the communication channel and in the communication channel, the method comprising:

phase modulating an information signal with a modulation index  $M$  that is not greater than 0.2 to compress a bandwidth of the information signal to form a narrow band or very narrow band phase-modulated information signal having a small or very small frequency deviation at the transmitting side of a narrow or very narrow band communication channel and in said communication channel;

suppressing upper and lower sidebands of the narrow band or very narrow band phase-modulated information signal;

transmitting, via the communication channel, said narrow band or very narrow band phase-modulated information signal with the suppressed upper and lower sidebands;

receiving the narrow band or very narrow band phase-modulated information signal with the suppressed upper and lower sidebands from the communication channel at the receiving side of the communication channel; and

expanding the frequency deviation of the received narrow band or very narrow band phase-modulated information signal with the suppressed upper and lower sidebands at the receiving side without expanding a bandwidth of said communication channel so as to form an expanded-frequency deviation information signal, the step of

expanding for improving a signal-to-noise ratio and performed such that a bandwidth of said narrow band or very narrow band communication channel is never expanded.

18. The method as set forth in claim 17, further comprising:

converting the expanded-frequency-deviation information signal to a low frequency signal or audio signal.

19. The method as set forth in claim 17, further comprising:

further processing the expanded-frequency-deviation phase modulated information signal.

20. The method as set forth in claim 17, further comprising:

converting the narrowband or very narrowband phase-modulated information signal with suppressed upper and lower sidebands received from the communication channel to an intermediate frequency (IF) information signal before expanding its frequency deviation.

21. The method as set forth in claim 20, further comprising:

passing the IF information signal through a half wave rectifier and schmitt trigger; and



cleaning an information signal output by the schmitt trigger with a wave shaping circuit.

22. The method as set forth in claim 17, wherein the expanding step includes:

expanding the frequency deviation of the received narrowband or very narrowband phase-modulated information signal with the suppressed upper and lower sidebands by frequency multiplication.

23. The method as set forth in claim 17, wherein the expanding step includes:

expanding the frequency deviation of the received narrowband or very narrowband phase-modulated information signal with the suppressed upper and lower sidebands by a phase-lock loop (PLL) frequency multiplier.

24. The method as set forth in claim 17, further comprising:

removing noise from the narrowband or very narrowband phase-modulated information signal with the suppressed upper and lower sidebands received from the communication channel before converting said narrowband or very narrowband phase-modulated information signal with the suppressed upper and lower sidebands to a low frequency signal or audio signal.

25. The method as set forth in claim 17, further comprising after the step of expanding the step of demodulating the expanded-frequency-deviation information signal to output an audio signal having sound quality comparable to sound recorded on CD-ROM.

26. A receiver for receiving and processing narrow band or very narrow band phase modulated information signals with suppressed upper and lower sidebands that have a predetermined small or very small frequency deviation due to compression of transmitted signals, and that have been transmitted over a narrow band or very narrow band communication channel, the receiver comprising:

means for receiving from the communication channel the narrow band or very narrow band phase-modulated information signals with the suppressed upper and lower sidebands, said narrow band or very narrow band phase-modulated information signals with the suppressed upper and lower sidebands having the predetermined small or very small frequency deviation; and

a circuit that expands the predetermined small or very small predetermined frequency deviation of the received narrow band or very narrow band phase-modulated information signals with the suppressed upper and lower sidebands..

27. The receiver according to claim 26, wherein the frequency deviation expanding circuit includes:

a phase lock loop circuit including a frequency divider having a dividing ratio that corresponds to a selected expansion of the frequency deviation.

28. The receiver according to claim 27, wherein an output signal of the phase lock loop circuit is down-converted to a second wideband or very wideband intermediate frequency information signal.

29. The receiver according to claim 26, wherein the frequency deviation expanding circuit includes:

a circuit having frequency-multiplying characteristics; and

a filter, connected to an output of the circuit having frequency-multiplying characteristics, the filter passing a multiplied-frequency signal component.

30. The receiver according to claim 26, further comprising:

means for removing noise from information signals from the receiving means before said signals from said receiving means are converted to a low frequency signal or audio signal.

31. A transmitter for transmitting an information signal via a communication channel connecting a transmitting side and a receiving side, involving phase modulation

with a modulation index  $M$  that is not greater than 0.2 to thus compress a bandwidth of the information signal to have a small or very small frequency deviation at the transmitting side of the communication channel and in the communication channel, the transmitter comprising:

means for phase modulating an information signal with a modulation index  $M$  that is not greater than 0.2 to compress a bandwidth of the information signal to form a narrow band or very narrow band phase-modulated information signal having a small or very small frequency deviation at the transmitting side of a narrow or very narrow band communication channel and in said communication channel; and

means for suppressing upper and lower sidebands of the narrow band or very narrow band phase-modulated information signal prior to transmission.

32. The transmitter according to claim 31, wherein said means for suppressing includes a bandpass filter.